Technical Analysis of Sutter Mutual Water Company's Water Needs

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Summary

The total water demand for SMWC has been calculated several ways as follows:

Summary of Calculated Water Needs (in acre-feet)	
BWMP 2020 Cropping Pattern	208,600
BWMP 2020 Drought Year Demand	210,600
BWMP 2020 Normal Year Demand	197,200
Peak Diversion in Recent years	224,784
SMWC High Water Use Cropping Pattern	220,600
WNA Based On Highest Historic Need	**220,100**

A contract quantity of 220,000 acre-feet will meet the needs of SMWC. SMWC has not had any reported salinity problems with lower diversions in the past therefore the risk associated with salinity problems in the future is minimal.

WNA Methodology

For contractors who supply water to meet agricultural demands, Reclamation estimated the district irrigation efficiency associated with the crop water information provided for a snapshot year. Both the district irrigation efficiency and the amount of intra-district conveyance losses are evaluated for reasonableness. Past beneficial use of CVP supplies is confirmed if the district irrigation efficiency is close to the current statewide average of 75 percent, or if a trend towards increasing district irrigation efficiencies over time is apparent; and if intra-district conveyance losses total 10 percent, or less, of the district's total water supply. In situations where some, or all, of these conveyance losses contribute to groundwater recharge for later use by the contractor, these "conveyance losses" are shown as groundwater recharge rather than conveyance losses. (Central Valley Project (CVP) Water Needs Assessments: Purpose and Methodology)

85% Documentation

The CALFED Agricultural Water Use Efficiency has a "Farm Quantifiable Objective Component" which states high farm efficiency is equal to an overall 75% efficiency. The resulting district efficiency was to achieve an overall maximum of 85% based on the high farm efficiency of 75%.

Agricultural water demand is defined as the sum of the district's irrigation water demand and the intra-district conveyance losses, where irrigation water demand is the product of the irrigated acreage in a district and the average farm delivery requirement. The farm delivery requirement is defined as the unit amount of water necessary to supply crop water needs in excess of effective precipitation and varies based on crop type, climate, irrigation water quality, soil salinity and irrigation method. The district's irrigation water demand is not necessarily the sum of all the on-farm irrigation water demands because such measures as recycling of intra-district return flows are effective in reducing the overall district irrigation water demand. The assumption for this analysis is that the continued implementation of water use efficiency measures between now and the year 2025 will further reduce the unit amount of water needed to grow crops in the future. Often, it is also assumed that district conveyance losses will decrease in the future. Specifically, district irrigation efficiencies are assumed to increase from an average of 75 percent currently to 85 percent by the year 2025. (Central Valley Project (CVP) Water Needs Assessments: Purpose and Methodology)

85% efficiency was used consistently for the Long-Term contract renewals such as the American River, Shasta and Friant Divisions, the Delta Mendota Canal and Tehama-Colusa Canal Contractors, etc.

Reduction to 80%

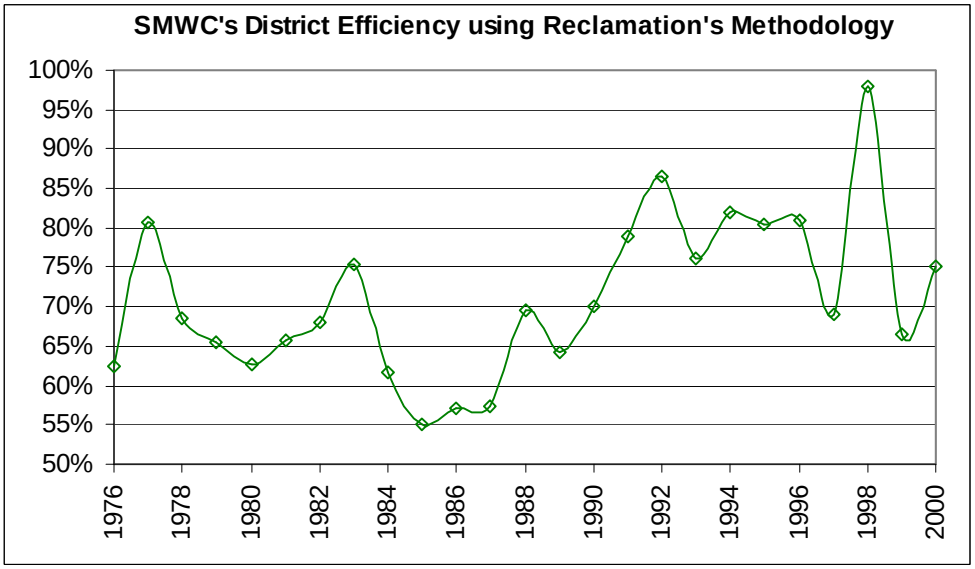
Certain districts, such as those with large elevation differences within their boundaries, have target district irrigation efficiencies of 80 percent based on the unavailability of certain water management options to increase overall district irrigation efficiency. (Central Valley Project (CVP) Water Needs Assessments: Purpose and Methodology)

This was expanded to include areas in the Sacramento Valley with water quality concerns. District efficiencies in areas of water quality concerns were reduced to 80%. This is to compensate for the added management issues associated with additional drainage requirements and reduced ability to recycle drainage water.

The Sacramento River Basinwide Water Management Plan (BWMP), discusses the efficiency at which overall water needs are met. This efficiency is quantified in the BWMP as a seasonal application efficiency (SAE), defined as the sum of ETAW and cultural water requirement divided by total applied water.

The BWMP further indicates that on a farm scale, SAE may be diminished by evaporation during conveyance, irrigation system leaks, leaching losses from the soil, etc. However, irrigation water that seeps to groundwater or becomes tailwater from surface drainage can be recovered on other farms. Unless water drains to an unusable pool (commonly termed an "unrecoverable loss"), such as contaminated or saline groundwater or water that is hydrologically at the end of

the irrigation network (e.g., drainage water flows to the ocean), it can be reused. Improvements in irrigation practices, planning, technology, and policies are expected to increase the average SAE from 73 percent to 80 percent for California over the next 2 decades. District-wide or basin-wide SAE will typically be higher due to the districts' or basins' reuse of drain and tail water.



The district efficiency calculated using Reclamations methodology, SMWC historic cropping patterns, and actual diversions confirm SMWC is capable of maintaining an average 80% efficiency as shown in the graph above. The last 10 year period yields an average efficiency of 79.3%.

Crop Water Use and Effective Precipitation

Reclamation's estimated crop water requirements for the year 2025 level of development are based on the CVP water contractors' estimates of future crops and acreage planted multiplied by estimates of the farm delivery requirements for each crop. Reclamation staff initially estimated crop water requirements for all regions using evapotranspiration (ET) and effective precipitation (EP) data from several sources: 1) California Department of Water Resources (DWR) Bulletin 160-98, 2) DWR Bulletin 113-3, and 3) Reclamation knowledge and experience. The ET and EP information was tabulated on a Detailed Analysis Unit (DAU) basis and then proportioned to each district based on the district's area in a DAU. The data was then used in combination with other traditional methodologies for determining crop water requirements to estimate each district's total irrigation water demand in the year 2025. (Central Valley Project (CVP) Water Needs Assessments: Purpose and Methodology)

Sacramento River Settlement Contractors WNA

The BWMP used a methodology where current crop acreage estimates and associated applied on-field water requirements are presented for each district in the context of a range around a projected *normalized* year (a condition developed by DWR, which assumed a 1995 cropping pattern that would have occurred absent the effects of 1987 to 1992 drought). This data was obtained from DWR in a tabular form, and included the following: Future crop acreage predictions are based on land survey trends, crop market outlook studies, land retirement (elimination of agricultural land with drainage problems), urban expansion projections, production models, and other variables.

Reclamation agreed to use the BWMP as the basis of the WNA for the participating Sacramento River Settlement Contractors. The data found in the BWMP was used to determine past reasonable and beneficial use with the 1995 Normal year data.

Due to the nature of the settlement contracts, Reclamation used the full contract quantities for the year 2020 analysis as the Settlement Contractors only water supply. The settlement contracts were negotiated in lieu of the Settlement Contractors exercising their water rights on the Sacramento River and its tributaries. This is a notable difference because the CVP WNA included Non-Contract water supplies such as groundwater (including the conjunctive use of surface and groundwater), State Water Project (SWP) supplies, local surface water supplies, recycled water, inter-district return flows and water transfers

Sutter Mutual Water Company WNA

The results from the WNA for SMWC has a maximum of 80,156 acre-feet of their 267,900 acre-feet contract quantity that is in excess of their full water need of 187,744 acre-feet in the year 2020. This was calculated using a 15% combined seepage and spill loss based on the diversion requirement. SMWC has 30% of total water under their Settlement Contract in excess of their water needs and thus does not meet the Reclamation's needs analysis criteria for the full contract supply. SMWC appears to have implemented practices that increase the district efficiency and reduce diversions to compensate for the mound of artesian connate (saline) ground water found within boundaries of SMWC.

The normal year 1995 WNA resulted in showing SMWC has reasonably and beneficially used the normalized diversions stated in the BWMP.

Irrigated Acreage Comparisons

The "Comparison of Land Classification Acreage To BWMP Acreage" table compares Reclamation records to the acreages used in the BWMP. A closer

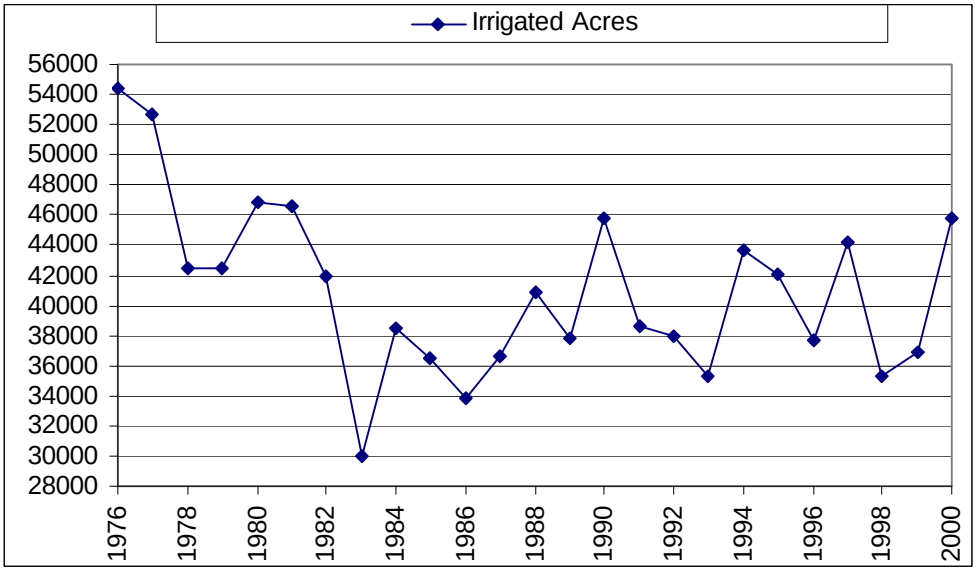
comparison of the Irrigable Acreage with the BWMP Net Irrigated Acreage shows that Glenn-Colusa Irrigation District (GCID), Natomas Central Mutual Water Company (NCMWC), Princeton Codora-Glenn Irrigation District (PCGID), Provident Irrigation District (PID), Reclamation District 104 (RD-1004), and Reclamation District 108 (RD-108) have net irrigated land that is less than irrigable acreage. Anderson-Cottonwood Irrigation District (ACID) also meets these criteria, however over one-third of the irrigable acreage is idled. Maxwell Irrigation District (MID), Meridian Farms Water Company (MFWC), Pelger Mutual Water Company (PMWC), and Sutter Mutual Water Company (SMWC) have higher net irrigated acreages than the irrigable acreage. Possible reasons for this include double crop acreage, or irrigation of Class 6 lands. However, PMWC, and SMWC also exceed the sum of the irrigable acreage and the Class 6 acreage. (Transmittal of the Final Water Needs Assessments for the Sacramento River Settlement Contracts).

Comparison of Land Classification Acreage To BWMP Acreage

District	Gross Acreage	Arable Acreage	Irrigable Acreage	Class 6 Lands	BWMP	
					Total District	Net Irrigated
ACID	33,240	22,179	21,070	10,001	32,000	13,900
GCID	173,394	140,871	133,827	15,578	170,000	130,200
MID	6,841	3,731	3,544	3,110	5,000	5,000
MFWC	10,793	10,116	9,610	677	15,600	9,700
NCMWC	39,982	36,428	34,607	2,927	36,000	34,100
PMWC	2,969	2,754	2,616	215	2,900	2,900
PCGID	12,113	11,287	10,723	826	11,700	10,000
PID	17,019	16,128	15,322	891	15,165	14,800
RD 1004	23,113	20,829	19,788	1,639	15,700	15,700
RD 108	58,863	53,969	51,271	4,637	47,600	51,000
SMWC	51,136	48,218	45,807	1,136	52,300	52,100

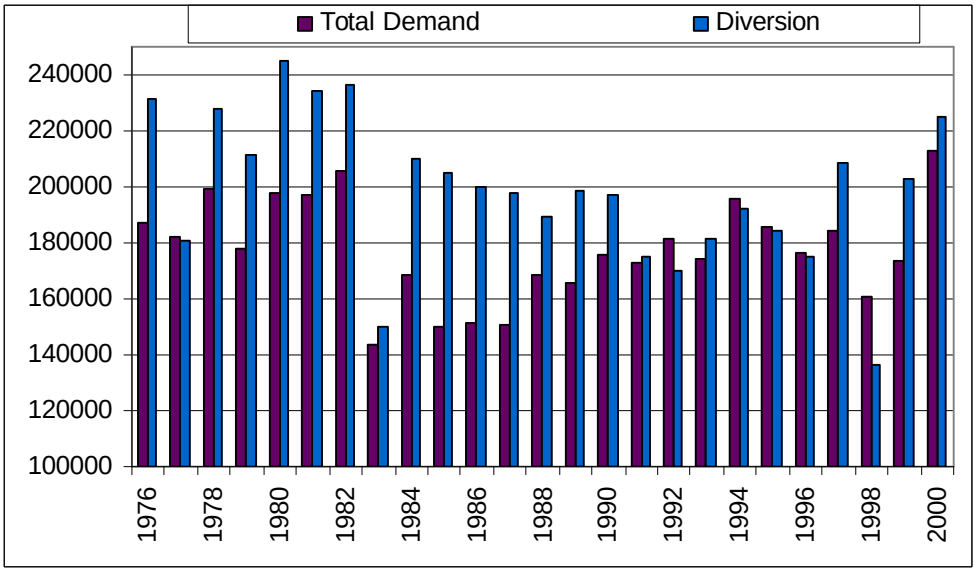
The typical cropping acreage for SMWC has been in the range of 34,000 acres to 46,000 acres since 1978 as shown below. The BWMP states the normalized 1995 and 2020 acreage for SMWC are 52,100 and 51,000 acres respectfully which also include double cropped acreage. The BWMP acreages exceed the sum of the irrigable acreage and the Class 6 acreage which is not supported by

SMWC's past cropping patterns since 1978 and is not representative of the total acres for other Sacramento River Settlement Contractors.



Historic Water Needs and Use

The results of the "Natural Resource Study for Reclamation District 1500 and Sutter Mutual Water Company", USDA Natural Resource Conservation Service, et. al., February 1996 (1996 NRCS Report) indicates that, while there is room for slight improvements, SMWC is efficiently utilizing the water resources available. Any dramatic modifications to the way water is managed in this basin requires further research and understanding of the ground water fluctuations and the movement of the connate water.



The 1996 NRCS report went on to say drastic cutbacks in water availability would most likely lead to an increase in soil salinity and impact crop productivity and have an adverse impact on wildlife habitats and populations.

SMWC has repeated that cutbacks in the contract supply may result in salinity problems. Based on historic diversions and the exercised use of the contract supplies, SMWC has diverted less than 220,000 acre-feet from 1983 through 2002 except for the year 2000 where diversions were measured at 224,784 acre-feet. Since 1983, water quality concerns over chemicals applied to rice have increased the time water must be held on rice fields before being discharged. This has greatly reduced the diversion requirements of SMWC as shown in the above graph showing Total Demands and Diversions.

Salinity Concerns

The 1975 Tanji, et. al. report, "Water and Salt Transfers in Sutter Basin, California" (Tanji) reported that analysis of soil samples taken during 1971-73 indicate Chloride (Cl) was not accumulating to any substantial degree in the soil profiles above the water table.

The 1996 NRCS report said present irrigation and drainage practices have kept salt levels in the soil down to a manageable level. Due to the low Electrical Conductivity (EC) of the irrigation supply water, it was estimated that less than one percent of the applied irrigation water is needed for leaching purposes. The leaching requirement for connate water suppression was not estimated. Continual productivity indicates the leaching requirement is being maintained.

In the 1996 NRCS report, there had not been a substantiated amount of salt buildup in soils in this area of high Total Dissolvable Solids (TDS). To address the concern of salt buildup in soils, the University of California, Davis tested for saturation extract conductivities and chloride concentration at representative sites from 1971 to 1978. Eleven of the 32 regular sample sites were located in the delineated areas of high TDS in drain waters. Based on these analyses Henderson (1978) recommended discontinuance of sampling. Henderson states that there was no increasing trend in the salinity or chloride of sampled soils over the period 1971 to 1978.

A number of factors stated by Tanji and the 1996 NRCS report contribute to the lack of buildup of salts in the soils overlying the connate water. These factors include but are not necessarily limited to: 1) a siltstone at a depth of approximately 40 inches occurring in patches over the area, 2) leaching and drainage, and 3) clay soils overlying a sandstone. (NRSC 1996)

The implied reduction of saline soils from 1965 to 1988 suggests that a salt buildup can be managed by leaching and drainage. Evapotranspiration over time, without downward leaching, causes salts to build up. The amount of irrigation required to provide the desired leaching can be established. Land

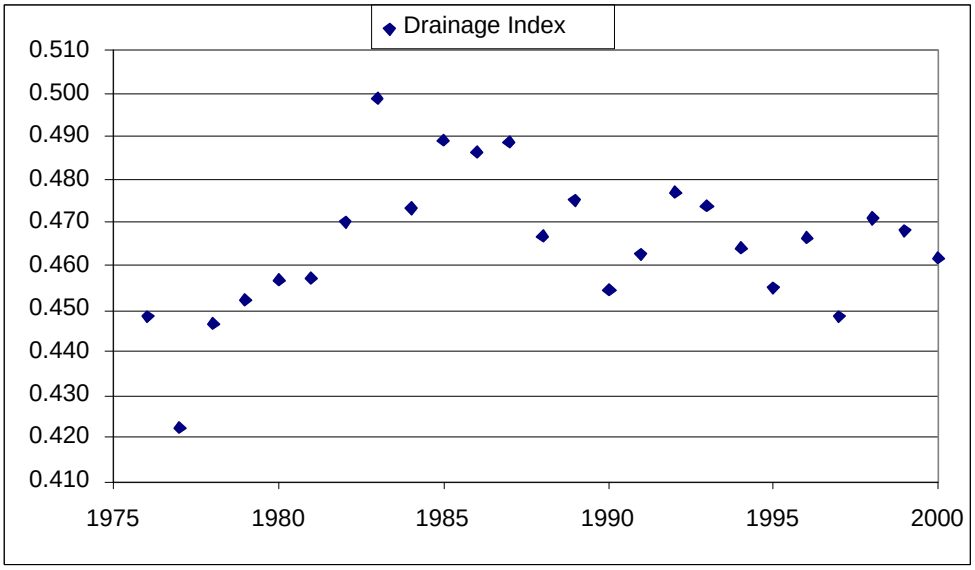
owners and operators appear to be applying ample irrigation at present to prevent salt buildup in the soils and apparently have leached (reclaimed) formerly saline soils. (1996 NRCS Report)

Historic Drainage Fraction

Tanji said the major outputs from the basin were surface drainage outflow and evapotranspiration loses to the atmosphere. There were no net deep percolation water losses into the substrata.

Tanji described a drainage index calculated as the ratio of the surface drainage output divided by the surface inputs. The surface drainage output is not readily available and the basin is assumed to be in balanced water conditions, therefore, surface drainage output was calculated as expected diversions minus consumptive use. Rainfall and net influx of subsurface water were ignored since both factors increase the required discharge requirements and raise the drainage index.

Tanji reported the drainage index ranged from 0.34 to 0.50 with a 9-year average of 0.42. Reclamation's calculations based on the historic cropping patterns and the expected diversion requirement using an 80% district wide efficiency yielded a drainage index from 0.42 to 0.50 with an average of 0.47. Reclamation's use of the 80% efficiency in the water needs assessment should not result in any significant risk of salinity problems for SMWC.



The perceived SMWC salinity problems have to do with recalculating of tail water that has the connate water mixed into it. SMWC's current practices are adequately addressing the concerns. The primary practice is to discharge the drain water into the Sacramento River when the drain water's TDS is over 750 ppm which does not occur very often during the irrigation season.

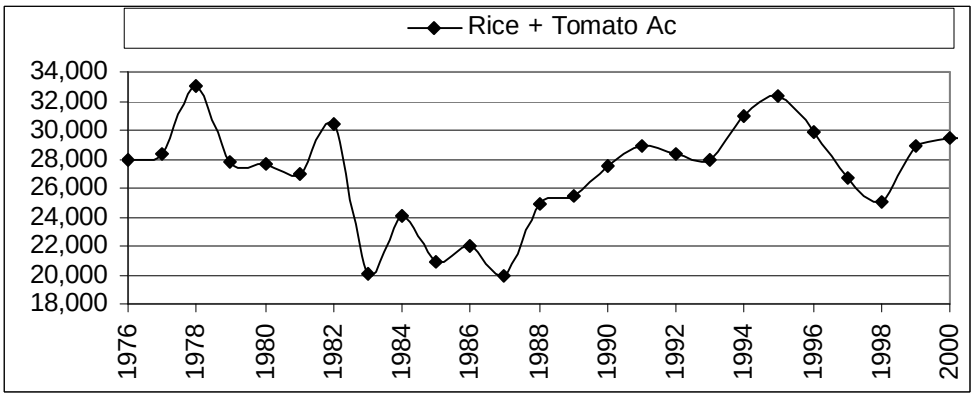
It should also be noted that 1977 and 1983 were significant hydrologic years. 1977 was significantly below 0.45 because 1977 was a severe, wide-spread drought year in California. Conversely, 1983 was the wettest year of record for the Sacramento Valley. Additionally, 1983 was the year of the Payment in Kind (PIK) Program by USDA. This program led to a very significant reduction in rice acreage in the Sacramento Valley and for 1983, SMWC reported 29,931 acres of irrigated land which was the lowest on record.

Revised WNA Based on Future Projections

Using SMWC's own estimates for their future cropping patterns as shown in the BWMP, Reclamation determined SMWC's need in the year 2020 to be 187,744 acre-feet. The WNA Methodology allows for a 10% error in the diversion quantities, which yields a total demand at 208,600 acre-feet. The SMWC calculations within the BWMP for the future year 2020 yields a total demand of 210,600 acre-feet under drought conditions and only 197,200 acre-feet in normal conditions.

Since the last published draft of the BWMP in September, 2000, SMWC has revised their future cropping patterns. Rice acreage was increased from 17,400 acres of rice to 26,000 acres, however, only in 1968 was this amount surpassed with 26,078 acres of rice. Also, tomato acreages were estimated to remain the same or decrease. Based on verbal information from SMWC, sugar beets should disappear from the area due to the lack of processing facilities nearby.

Information on the other crops grown, within SMWC, were not given. A trend analysis was done on the historical record to make that determination. Rice acreage was set to 26,000 acres and tomatoes were estimated to be 5,000 acres. The rice plus tomato acreage was plotted and the total of 31,000 acres was determined to be approximately 2,000 acres over the reasonable estimate for the long term record.



The total irrigated acreage in the district including double cropping was set to 45,810 acres which is equal to the year of 2000 peak water demand acreage. The total demand is 220,600 acre-feet using this theoretical cropping pattern. Reclamation would be technically hard pressed to claim this was a reasonable estimate of the SMWC's future water needs based on the historic records.

Revised WNA Based on Highest Past Need

Reclamation calculated the water needs (total demand) SMWC would have required using an 80% district efficiency based on SMWC's historic cropping patterns from 1976 through the year 2000 as shown in the table below. The second to highest demand occurred in 1982 at 205,964 acre-feet. The highest year was 2000 at 212,872 acre-feet. Using the 2000 data, correcting for known errors of -1.7%, and allowing a 5% for unknown errors, yields a total demand of 220,100 acre-feet. This amount allows for 10,000 acre-feet of cushion for low rainfall years, operational problems, etc.

Year	FDR	Irrigated Acres	Demand Col.19	Losses	Total Demand
1976	2.9	54419	157815	29644	187459
1977	2.9	52695	152816	29644	182460
1978	4.0	42456	169824	29644	199468
1979	3.5	42434	148519	29644	178163
1980	3.6	46818	168545	29644	198189
1981	3.6	46625	167850	29644	197494
1982	4.2	41981	176320	29644	205964
1983	3.8	29931	113738	29644	143382
1984	3.6	38523	138683	29644	168327
1985	3.3	36516	120503	29644	150147
1986	3.6	33828	121781	29644	151425
1987	3.3	36656	120965	29644	150609
1988	3.4	40864	138938	29644	168582
1989	3.6	37785	136026	29644	165670
1990	3.2	45731	146339	29644	175983
1991	3.7	38646	142990	29644	172634
1992	4.0	37960	151840	29644	181484
1993	4.1	35293	144701	29644	174345
1994	3.8	43709	166094	29644	195738
1995	3.7	42094	155748	29644	185392
1996	3.9	37677	146940	29644	176584
1997	3.5	44184	154644	29644	184288
1998	3.7	35330	130721	29644	160365
1999	3.9	36929	144023	29644	173667
2000	4.0	45807	183228	29644	212872

The total demand of 220,000 ac-ft will meet the needs of SMWC based on the last 20 years of historic diversions and should not result in any significant risk of

salinity problems for SMWC. Article 9, (c)(2) of the current Settlement Contract states in paraphrase that the contractors' water use during the contract period in no way reflects the water use of the contractors if they exercising their water rights. Therefore, this reduction in their contract quantities should not affect their water right claims in any future adjudication proceedings in the Sacramento River Basin.